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30.0 CORROSION CONTROL

30.1 INTRODUCTION

This section contains design criteria for the pipeline corrosion control system. Criteria are presented for the cathodic protection system and the protective coating system.

Design procedures and proposed operating philosophy for the pipeline corrosion control system are also discussed in this section.

Further evaluations will be required to confirm the suitability of the proposed corrosion control system and to ensure comparability with the Trans Alaska Pipeline System (TAPS) corrosion control system.

30.2 CODES AND CRITERIA

30.2.1 Codes

- Code of Federal Regulations, Title 18 – Conservation of Power and Water Resources.
- Code of Federal Regulations, Title 49 - Transportation, Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards.
- National Association of Corrosion Engineers, Recommended Practice, "Control of External Corrosion on Underground and Submerged Metallic Piping Systems," NACE RP0169-96.
- Federal Right-of-Way Grant for the Alaska Natural Gas Transportation System Alaska Segment, Serial No. F-24538 (December 1, 1980), as such may be updated and/or amended from time to time.
- Federal Energy Regulatory Commission conditional certificate of public convenience and necessity, issued on December 16, 1977, as such is finalized.

30.2.2 Criteria

30.2.2.1 Cathodic Protection

The cathodic protection system will be capable of maintaining the pipeline at a minimum negative (cathodic) potential a required in Section 6 of the NACE Standard RP0169-96.

- The system will be capable of maintaining the pipeline below the cathodic disbondment potential for the external pipeline coating selected.
- The system will be compatible with the existing TAPS corrosion control system.
- The system will be designed for a 50-year life.

- The system will be designed to be compatible with the selected external coating system.

External Coating Selection

The pipeline will be externally coated with a material having a high corrosion resistance and a high electrical resistance which will be suitable for the following:

- Minimal ultraviolet degradation for a minimum time period of 2 years (160°F surface temperature).
- Construction stresses resulting from transportation, and handling, at ambient temperatures ranging from -50°F to +100°F.
- Bending, lowering-in and backfilling at ambient temperatures ranging from -50°F to +100°F.
- Field repairs at ambient temperatures ranging from -50°F to +100°F.
- Overcoating with insulating material, concrete weight coating, concrete weights or combinations of these materials.
- In-service pipeline operating temperatures ranging from the minimum to maximum design operating gas temperature in accord with the project design basis.
- In-service exposure to frozen soil surroundings.
- Plant application.

The coating will be fully compatible with the cathodic protection system.

30.3 DESIGN PROCEDURES

30.3.1 External Coating

The external pipeline coating chosen for the project must satisfy a demanding set of performance criteria developed to contend with the harsh arctic environment together with design compatibility requirements between its insulating, physical strength, and application characteristics. Generic types of external coatings will be analyzed and compared to determine which type more fully satisfies all requirements. Coating systems presently under consideration are:

- Fusion bond epoxy systems
- Polyethylene systems
- Liquid epoxy/ urethane systems
- Multi-layer systems

Minimum acceptance performance values in the following areas will be established:

- Impact Resistance
- Abrasion Resistance

- Adhesion (to steel)
- Penetration
- Disbondment
- Bendability
- Weathering
- Permeability
- Elongation
- Coefficient of Friction
- Adfreeze Bond strength
- Hardness
- Shear-Creep Deformation
- UV Degradation
- Dielectric Strength
- Field repairability

Coating evaluations and review of existing industry information will be used to establish minimum acceptable performance values. These performance values will be specified in the coating material specification for the particular coating system selected.

30.3.2 Electrical Isolation of Pipeline Sections

The requirements for electrical isolation will be determined during detailed design of the external coating and cathodic protection systems.

30.3.3 Sacrificial Anodes/unfrozen soils

For short term protection, primarily in the thawed areas prior to pipeline operation, sacrificial anodes may be installed along the pipeline to supplement the impressed current system in the following areas:

- River and stream crossings where the thaw area extends to pipeline depth in all areas.
- At all electrically insulating joints where erratic current discharge could take place.
- In unfrozen soils, where required, based on geotechnical information and available soil resistivity data.
- As required to control telluric current buildup and discharge. Sacrificial anode materials will be placed in areas with relatively low resistance in relation to the surrounding area. These areas will include the unfrozen zones identified in project geotechnical evaluations.

Tests to determine the effectiveness of galvanic anode materials will be reviewed and/or developed as required.

30.3.4 Rectifiers for unfrozen soils

For long term protection during pipeline operation, panel mounted rectifiers will be installed at the compressor station locations and at the Gas Conditioning Plant metering point and at the Canadian Border. Units used will each have a specified design output. Depending on site-specific requirements, which will be determined by a cathodic protection field program, the units will also be connected to one or more impressed current groundbed(s). Rectifiers will be mounted inside of control buildings at all sites.

Liaison will be undertaken with Alyeska Pipeline Service Company (APSC) to evaluate the compatibility of constant potential and constant current rectifiers with the existing TAPS cathodic protection system.

30.3.5 Insulated Pipe

Sacrificial anodes will be used for protection of thermally insulated pipe where practical. The methods used will be developed in conjunction with the insulation design.

30.3.6 Groundbeds

Impressed current groundbeds will be located at selected sites along the pipeline. The groundbeds will be installed at meter sites where appropriate. The type and size of each groundbed will be determined by detailed soil analyses which will be established on a site-specific basis.

30.3.7 Foreign Structures

The interactive (stray current) effects of the pipeline corrosion control system with TAPS, foreign structures, or other facilities will be evaluated. Requirements for any electrical bonds between the gas pipeline and TAPS will be evaluated on a site-specific basis.

30.3.8 Test Stations

Test stations are required for proper system monitoring and evaluation. The design of the corrosion control system will include the following five types of test stations:

TYPE A - Pipe-to-soil potential measurement test station (Figure 30-1). This is the basic test station and will be located along the pipeline at approximately 1-mile intervals unless an area is covered by some other type of test station.

TYPE B - Sacrificial anode test stations (Figure 30-2). This type of test station will be installed at locations where sacrificial ribbon anode material is used. These test stations will serve as pipe-to-soil potential measurement points and galvanic current measurement points.

TYPE C - IR drop/pipeline current flow measurement test station (Figure 30-3). These test stations will serve as pipe-to-soil potential measurement points and after' field calibration, as pipeline current flow measurement points. They will be located at approximately 2-mile intervals.

TYPE D - Potential/Foreign structure measurement test station (Figure 30-4). These test stations will serve as pipe to soil potential measurement points for both the foreign structure and the pipeline. At foreign pipeline crossings, they will serve as interference measurement and bond stations if necessary.

TYPE E - Insulating joint test station (Figure 30-5). This type of test station will be installed only at insulating joints and will be used to measure pipe to soil potentials on both sides of the joint. This type of station will also serve as an electrical safety valve which will shunt large current surges around the insulating joint

30.3.9 Monitoring

The pipeline monitoring system will consist of the test stations mentioned above. The pipeline will be further monitored by a communications system..

30.3.10 Telluric Current Control

Telluric currents are those currents which are present in the earth due to the magnetic variations produced by the sun and other sources. They can cause problems when measuring pipe-soil potentials, and in other cathodic protection measurements. The design for the control of these currents recognizes the importance of minimum exposure to electrical variations in the earth's path by reducing the overall length of the pipeline into the electrically isolated segments. The use of sacrificial anode material at discharge points and grounding cells at insulated joints will assure that current activity will not damage the pipeline. The appropriate use of dataloggers, coupons, data processing algorithms and similar techniques will be reviewed to mitigate the effect of telluric currents on cathodic protection measurements.

30.3.11 Frozen Soils

Frozen soils cathodic protection requirements will be designed on a site specific basis. Thawed areas within identified frozen soil sections along the alignment will require special site investigation and design requirements on a site specific basis.

30.4 FIGURES AND TABLES

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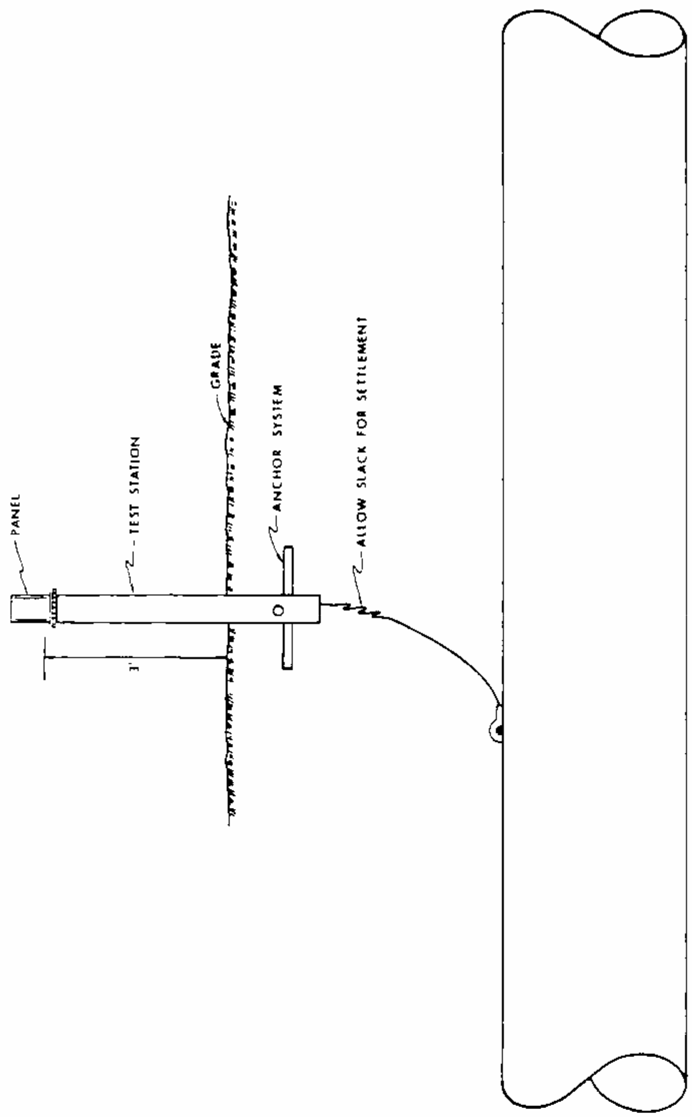

**Figure 30-1 Type "A" Test Station
Potential Measurement**

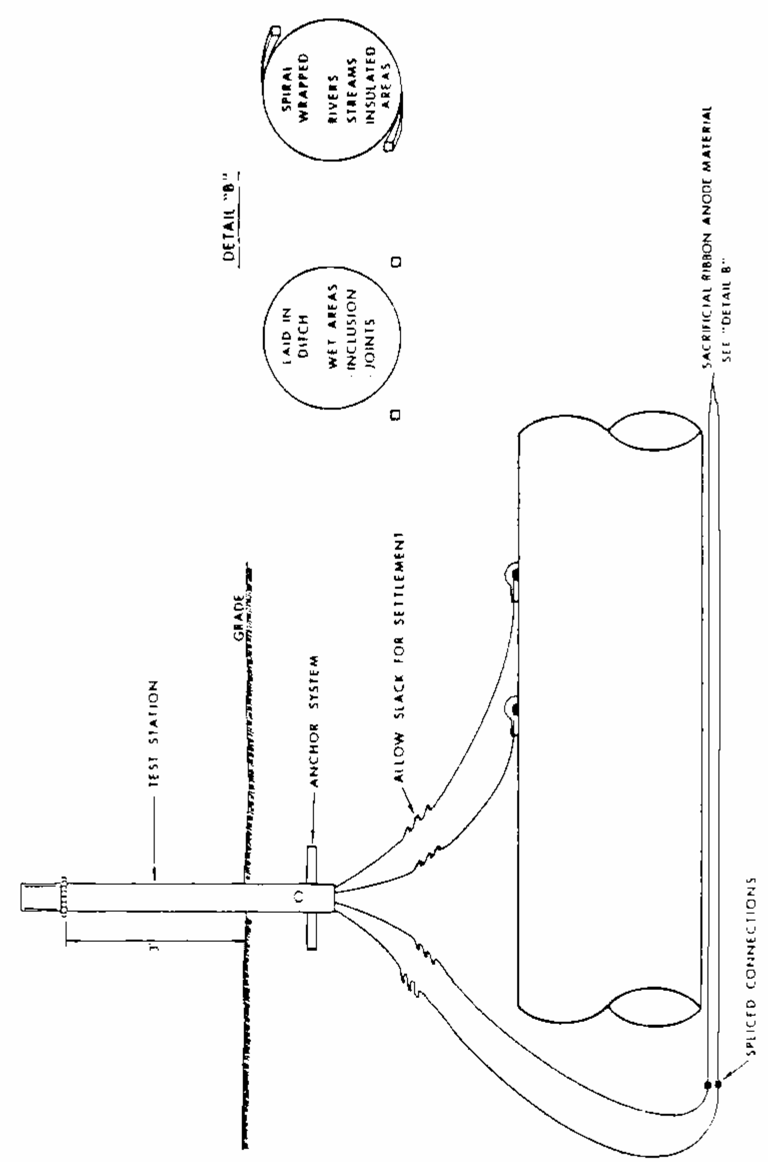

Figure 30-2 Type "B" Test Station
Sacrificial Anode

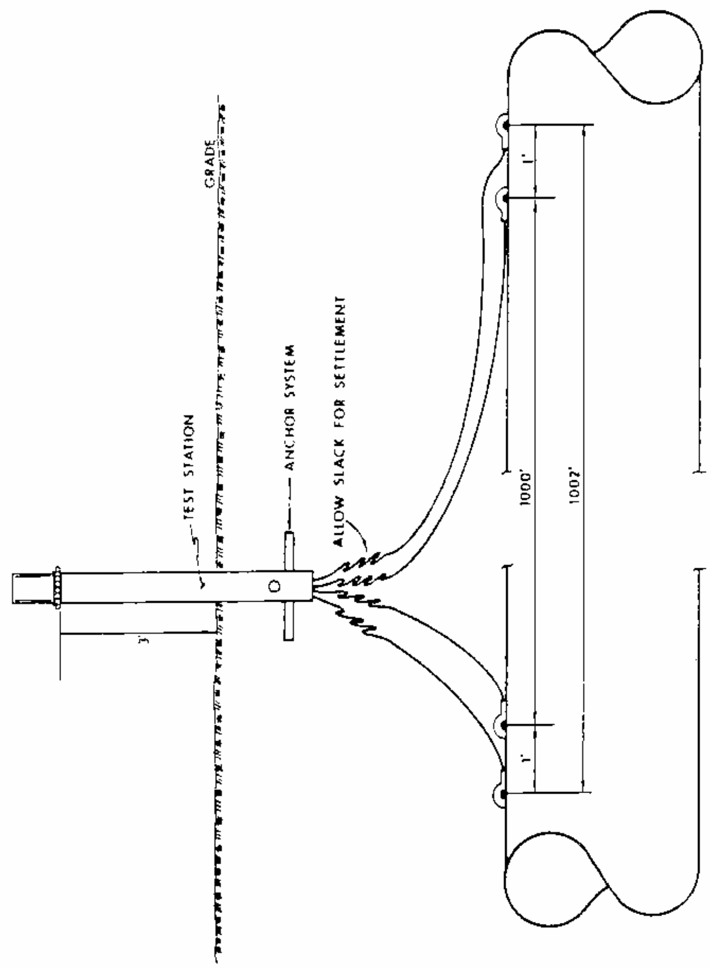

Figure 30-3 Type "C" Test Station Potential Measurement and IR Drop

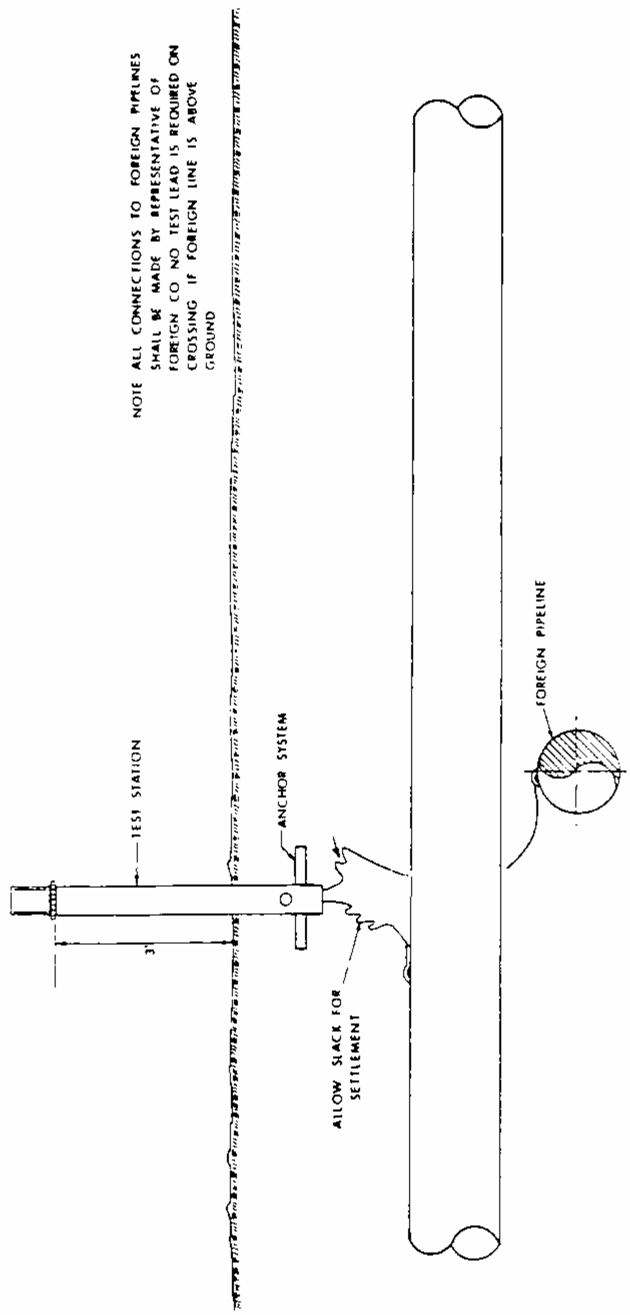

Figure 30-4 Type "D" Test Station Foreign Pipeline Crossing

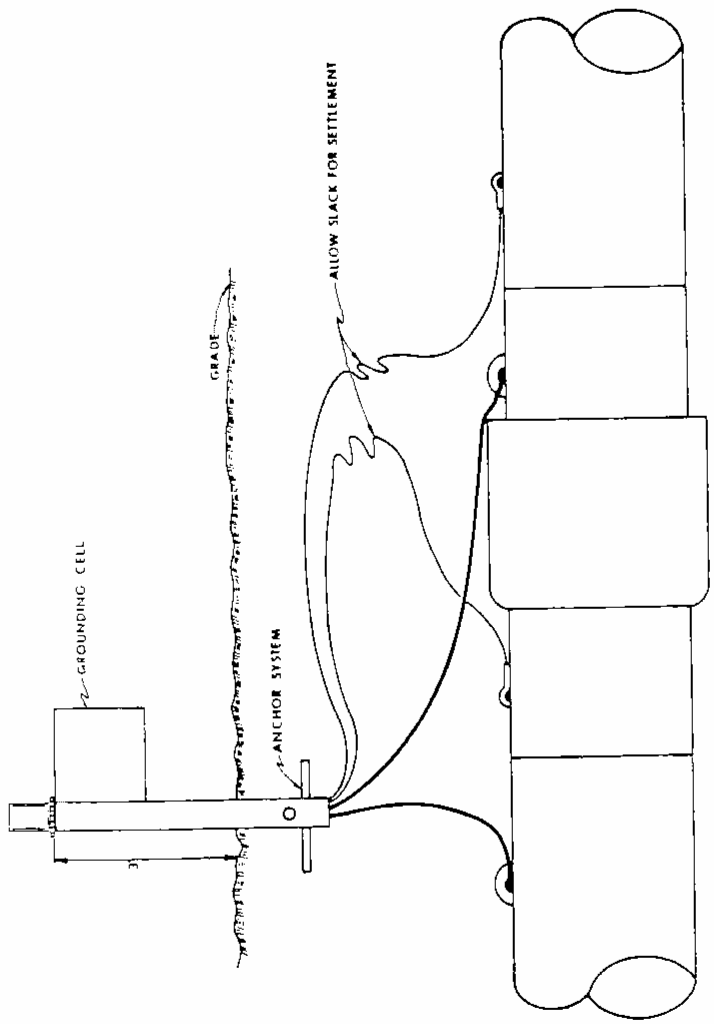

**Figure 30-5 Type "E" Test Station
Insulated Joint**

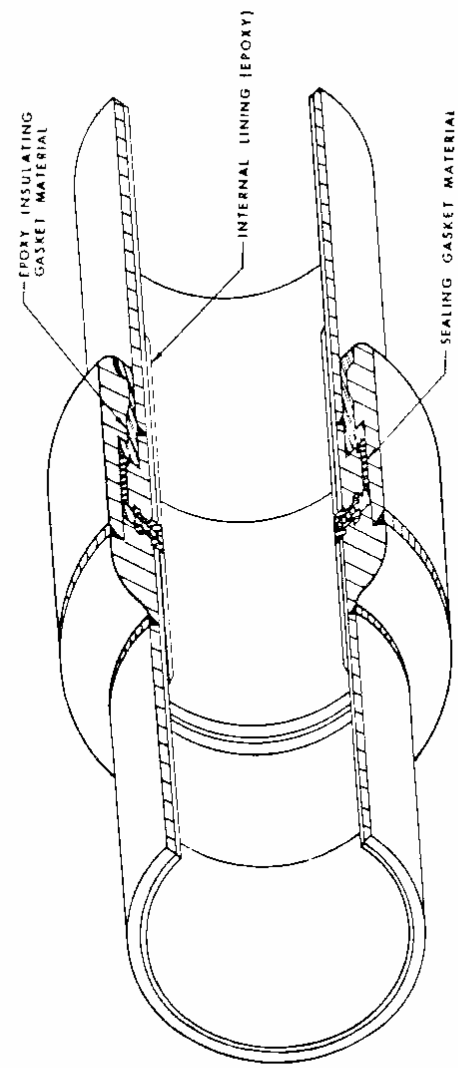

Figure 30-6 Typical Insulating Joint

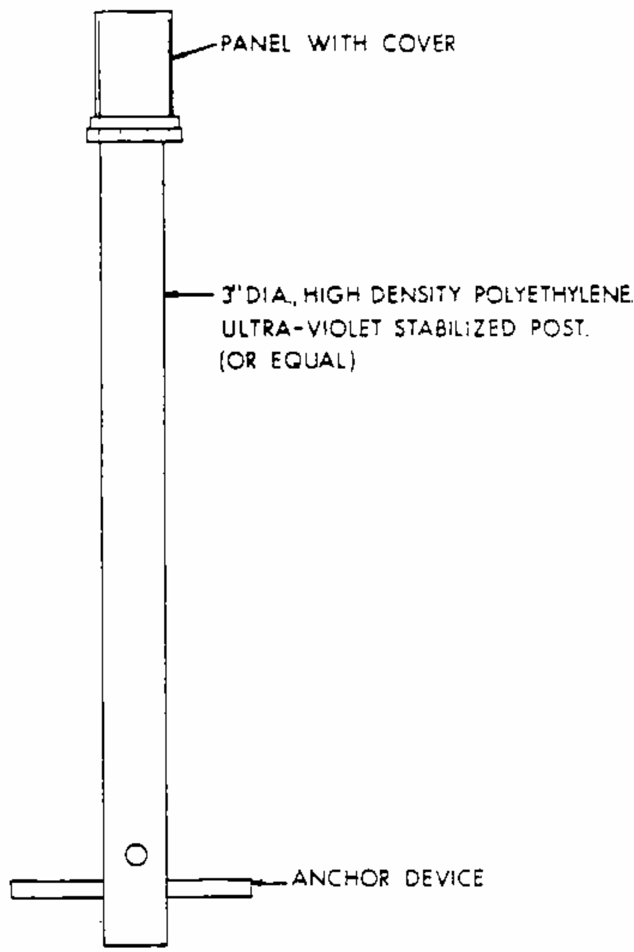

Figure 30-7 Typical Test Station

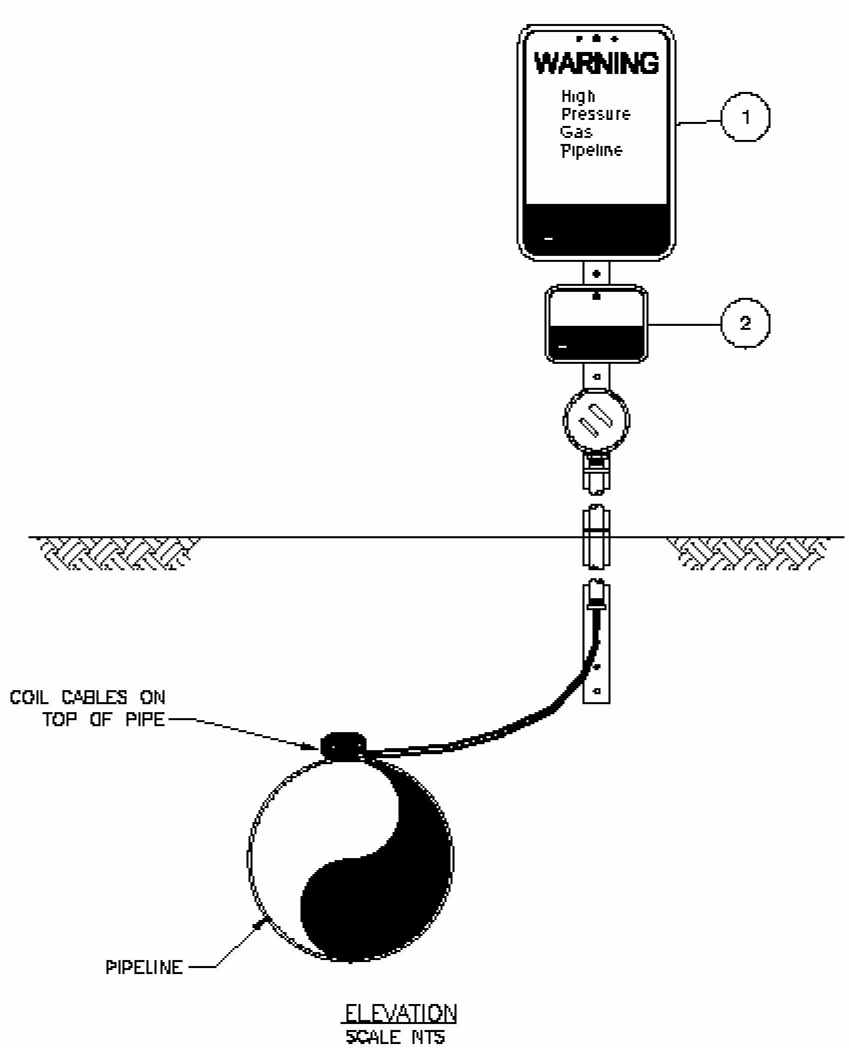

Figure 30-8 Typical Signage at Cathodic Protection Test Station

Notes: 1) Pipeline Warning Sign

2) C.P. Test Station Location Sign, showing milepost